Problem 2.1

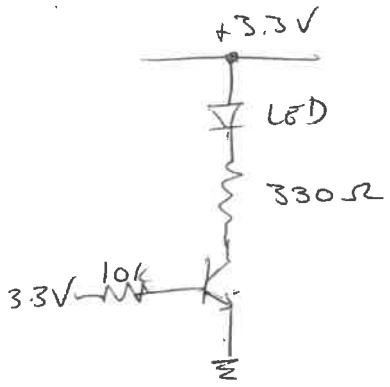
Collector Emitter Circuit

$3.3V - 2V - 330\,I - 0.6 = 0$

↑ LED diode ↑ BE diode

$0.7 = 330\,I$

$I \cong 2\,mA$



Base – Emitter

$3.3V - I\,10000 - 0.6V = 0$

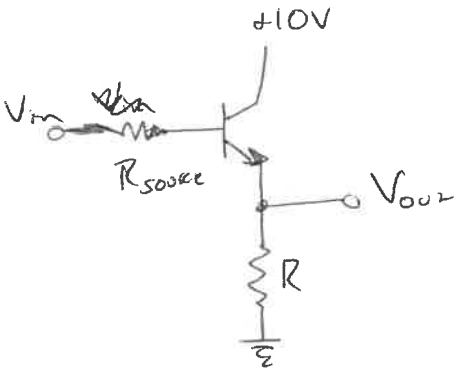
$10000\,I = 2.7V$

$I \simeq 0.3\,mA$

$\beta \geq 10$!

so typically in saturation

Problem 2.4



Make a small change ΔV_B at emitter.

$$\Delta I_B = \frac{\Delta V_B}{R_S} = \frac{\Delta V_E}{R_S}$$

still have $I_E = I_C + I_B$

$$I_E = (\beta + 1) I_B$$

$$\Delta I_B = \frac{\Delta I_E}{\beta + 1}$$

$$\frac{\Delta I_E}{\beta + 1} = \frac{\Delta V_E}{R_S}$$

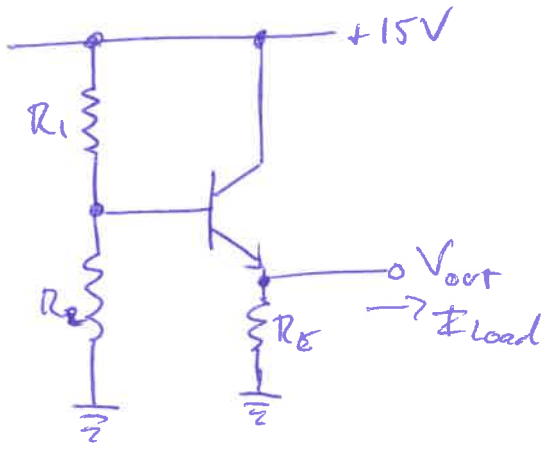
$V = IR$

$R = \frac{V}{I}$

$$\frac{R_S}{\beta + 1} = \frac{\Delta V_B}{\Delta I_E} = r_{out}$$

$$Z_{out} = \frac{Z_{source}}{\beta + 1}$$

Problem 2.5



max $I_{load} = 25mA$

pick $R_E = 1k$

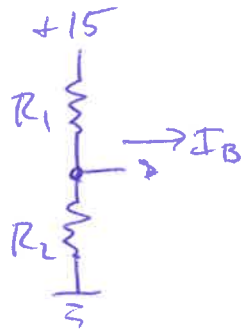
want $V_{out} = 5V$ so current through R_E, $I_E = \frac{5V}{1000\Omega} = 5mA$

so total current at emitter side under full load is $25mA + 5mA = 30mA$.

So base current under load $= \frac{30mA}{\beta}$

$I_B = 3\times10^{-4}A$ if $\beta = 100$.

So now look at divider,



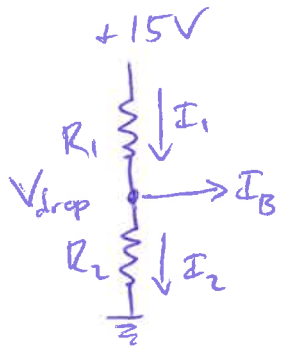
with no load, $I_B = 0$ want V across R_2 to be 5.6V, (lose ~0.6V across transistor)

$$5.6V = \frac{R_2}{R_1+R_2}\,15V$$

$$5.6R_1 + 5.6R_2 = 15R_2$$

$$5.6R_1 = 9.4R_2 \rightarrow R_2 = \frac{5.6}{9.4}R_1$$

with our I_B load, we don't want voltage to drop by more than 5%



$$V_{drop} = 5.6V - 0.05(5.6V) = 0.95(5.6V)$$

$$I_1 = I_2 + I_B$$

$$\frac{V_1}{R_1} = \frac{V_2}{R_2} + I_B$$

$$V_1 = 15 - (0.95)(5.6)$$

$$V_2 = 0.95(5.6)$$

$$\frac{15-0.95(5.6)}{R_1} = \frac{0.95(5.6)}{R_2} + I_B$$

plug in R_2 from above.

$$\frac{15}{R_1} - \frac{0.95(5.6)}{R_1} = \frac{0.95(5.6)}{5.6R_1}9.4 + I_B$$

$$\frac{15}{R_1} - \frac{(0.95)15}{R_1} = I_B$$

$$\frac{0.05(15)}{R_1} = I_B$$

$$R_1 = \frac{(0.05)(15)}{I_B} = 2500\Omega$$

so $R_2 = 1490\Omega$